CALIPSO, CloudSat, CERES, and MODIS Merged Data Product

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CALIPSO-CloudSat-CERES-MODIS Merged Product

- Funded by the NASA Energy Water Cycle Study (NEWS) project.

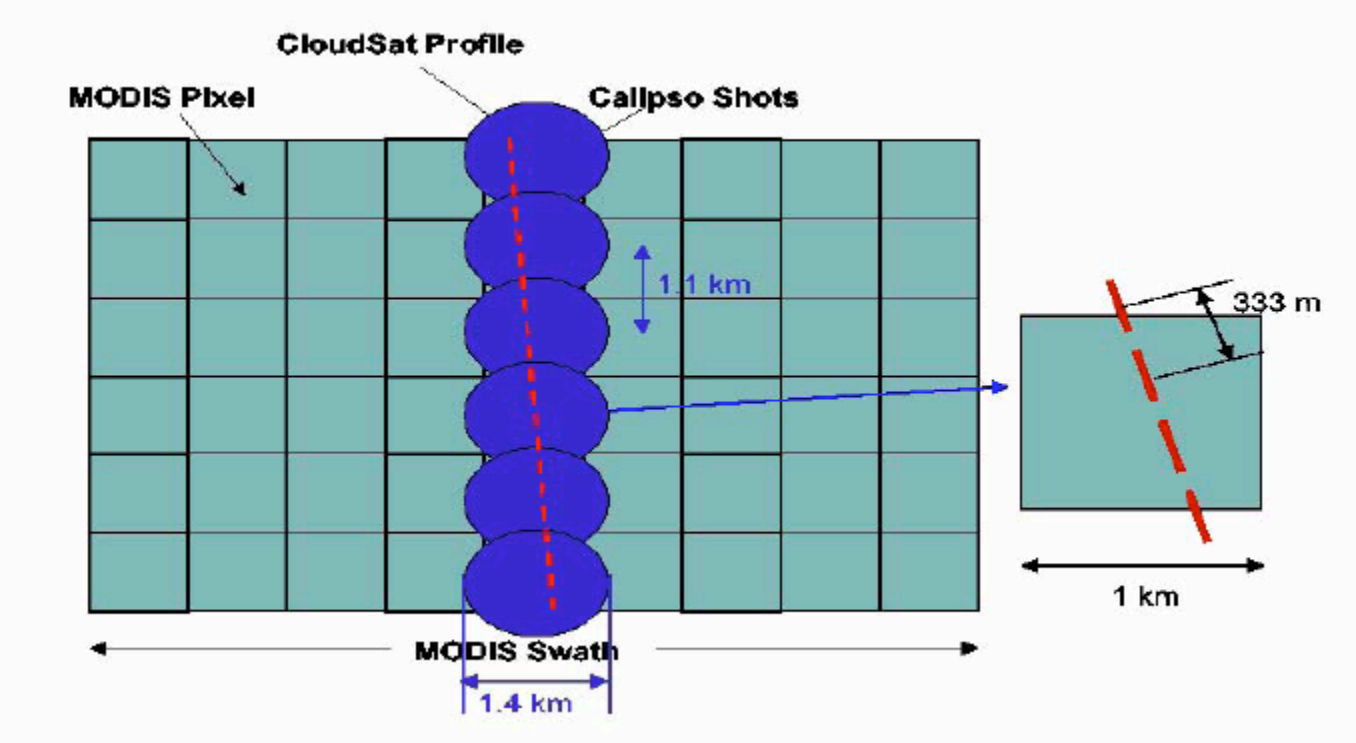
Expected contribution of the product

To provide a global data set along the lidar/radar ground track with the most accurate and comprehensive aerosol properties, cloud properties, and vertical radiative flux profiles to climate researchers.

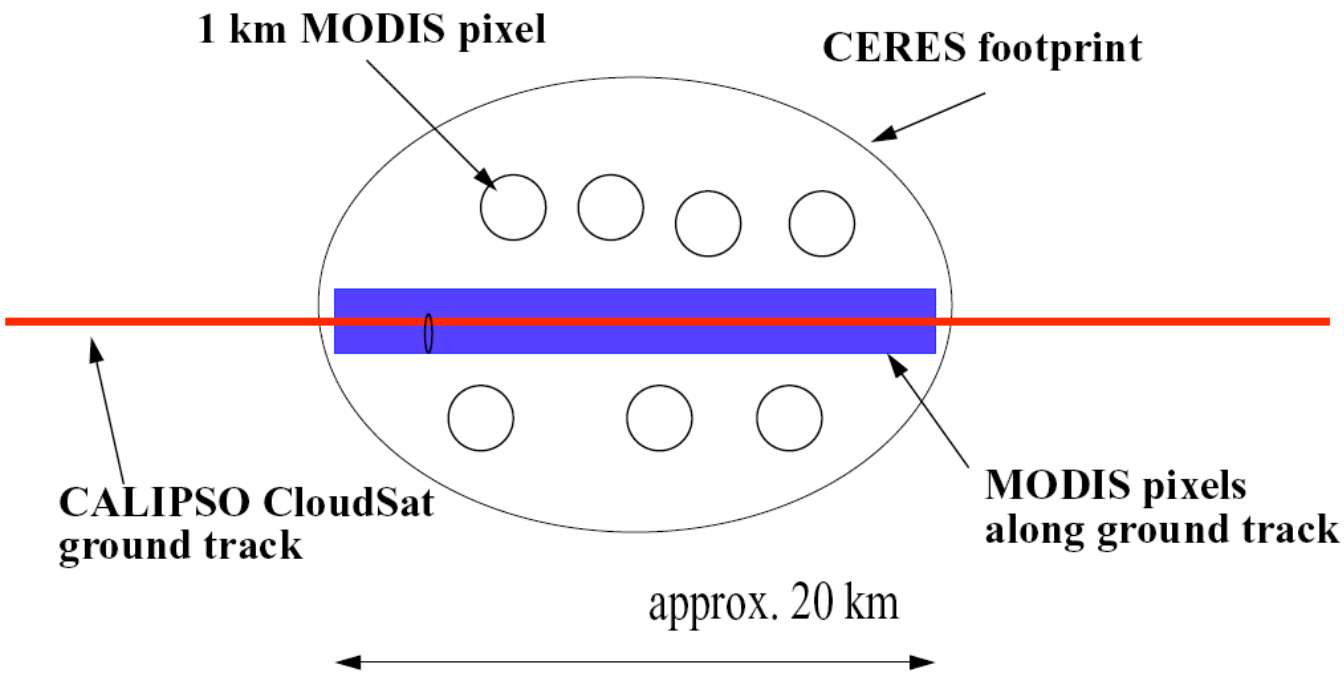
Area of studies that are greatly improved by our data set includes:

1. Assimilation and prediction by global aerosol models through better understanding of aerosol layer location.
2. Better understanding of multi-layered and polar cloud systems and their radiative impacts.
3. Better understanding of frequency of occurrence of thin cirrus and boundary layer clouds and their radiative impacts.

CALIPSO-CloudSat-MODIS merging



CALIPSO CloudSat MODIS merging with CERES



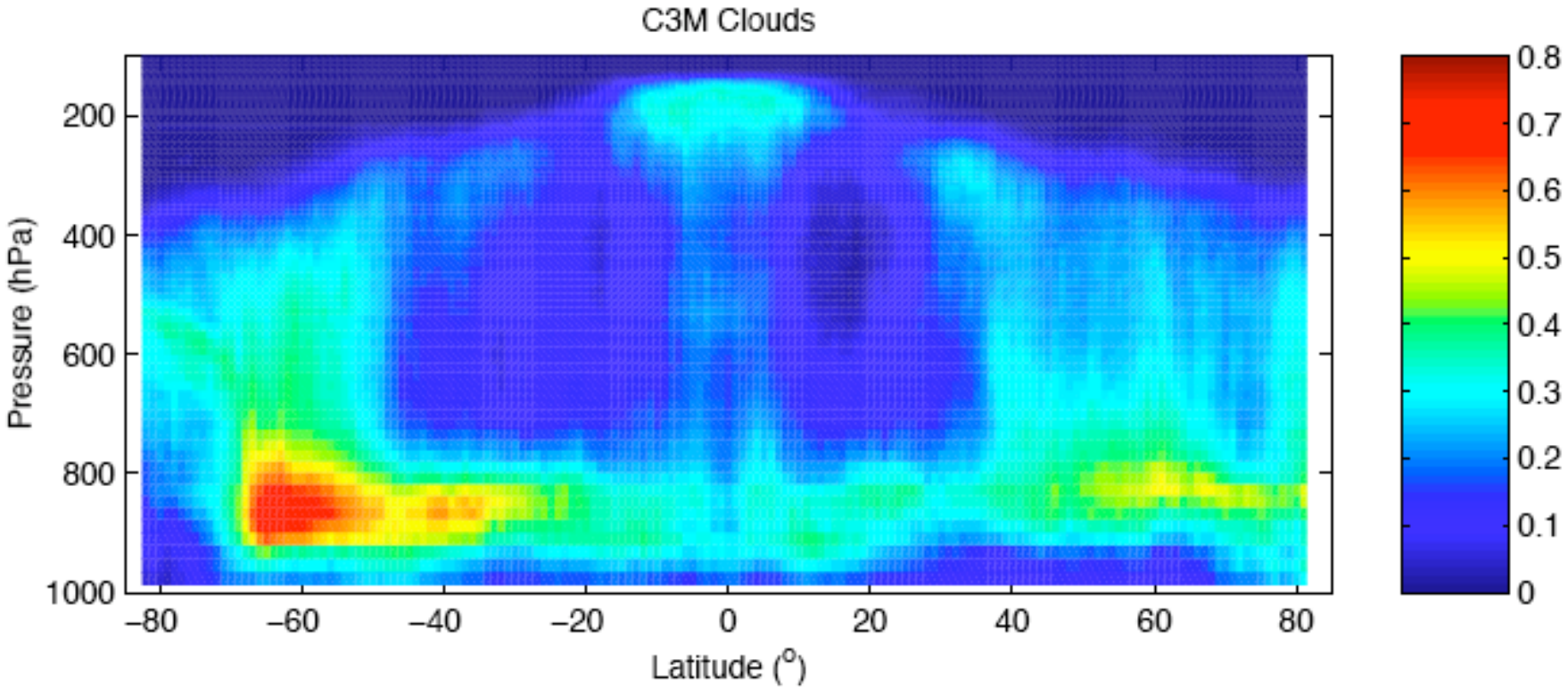
Variables included in the product

- Cloud (up to 16 cloud groups within a CERES footprint) and aerosol vertical profiles.
- CALIPSO-derived aerosol optical thickness
- CALIPSO-derived aerosol types
- CALIPSO-derived cloud extinction profiles
- Precipitation flag from CloudSat
- Atmospheric temperature, water vapor and heating rate profiles.
- MODIS derived spectral surface albedo and snow and ocean spectral albedos from Jin's model
- MODIS derived cloud properties (ed3 and enhanced algorithms)

Cloud masking strategy

Cloud Boundary	CALIPSO	CloudSat	Merged Cloud Boundary
Top	Detected	Detected	Higher Cloud Top
Top	Detected	Undetected	CALIPSO Cloud Top
Top	Undetected	Detected	CloudSat Cloud Top
Base	Not Attenuated	Undetected	CALIPSO Cloud Base
Base	Not Attenuated	Detected	CALIPSO Cloud Base
Base	Attenuated	Detected	CloudSat Cloud Base
Base	Attenuated	Undetected	CALIPSO lowest unattenuated level

Merged clouds



Cloud occurrence within 200 vertical by 1 degree latitude layers

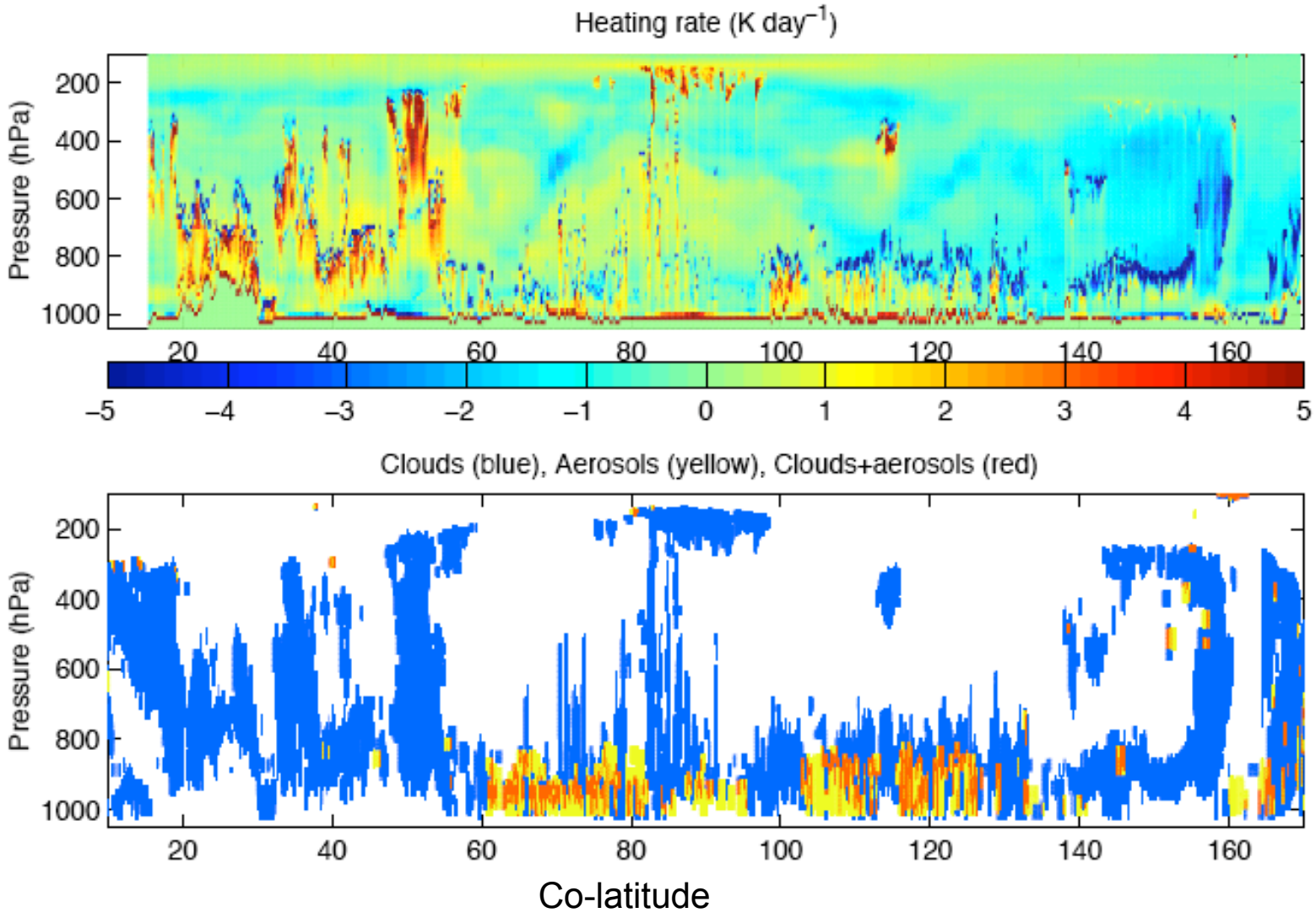
Enhanced CERES-MODIS cloud algorithm

- Change MODIS-derived cloud top height to match CALIPSO-CloudSat derived cloud top height.
- If 0.3 < tau < 2 then place MODIS cloud top at tau/2
- If tau>2 then place MODIS cloud top at tau = 1.

Flux computations

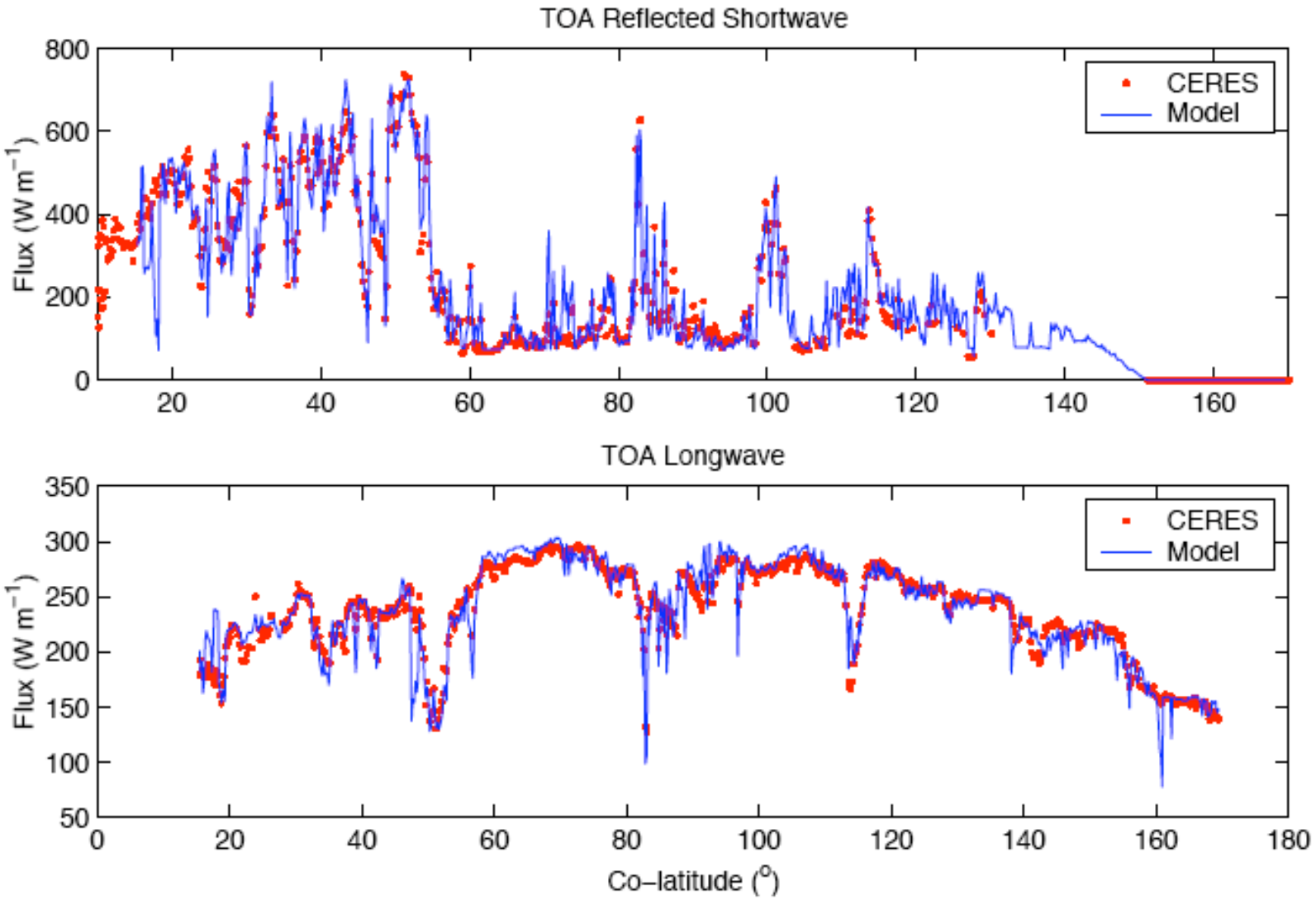
- CALIPSO-CloudSat cloud mask.
- CALIPSO and CloudSat derived extinction profiles are scaled by MODIS derived optical thickness.
- MODIS derived cloud particle size.
- CALIPSO-derived aerosol optical thickness.
- If CALIPSO aerosols are not available, MODIS-derived or MATCH aerosol optical thickness.

Heating rate profile



Radiative effect of Cirrus, cloud overlap, cloud-aerosol overlap

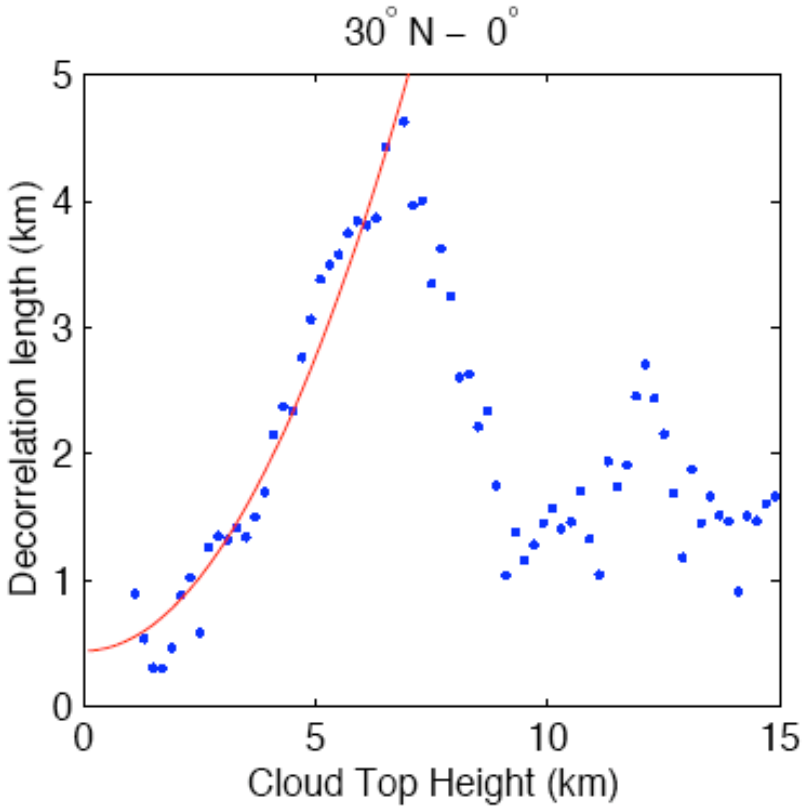
Comparison with CERES fluxes

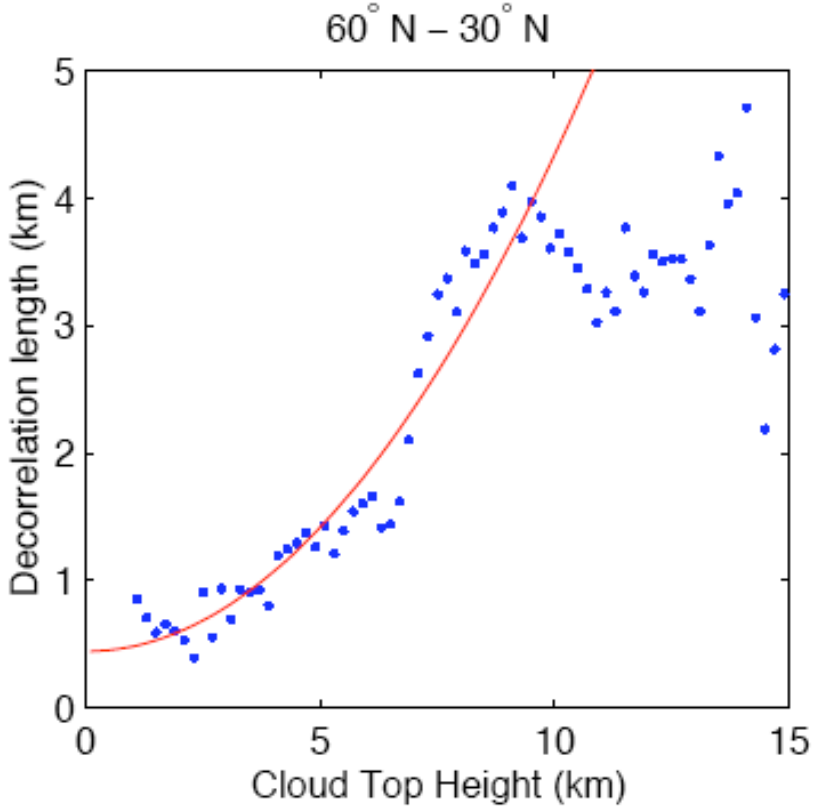


Preliminary comparison (1 orbit)

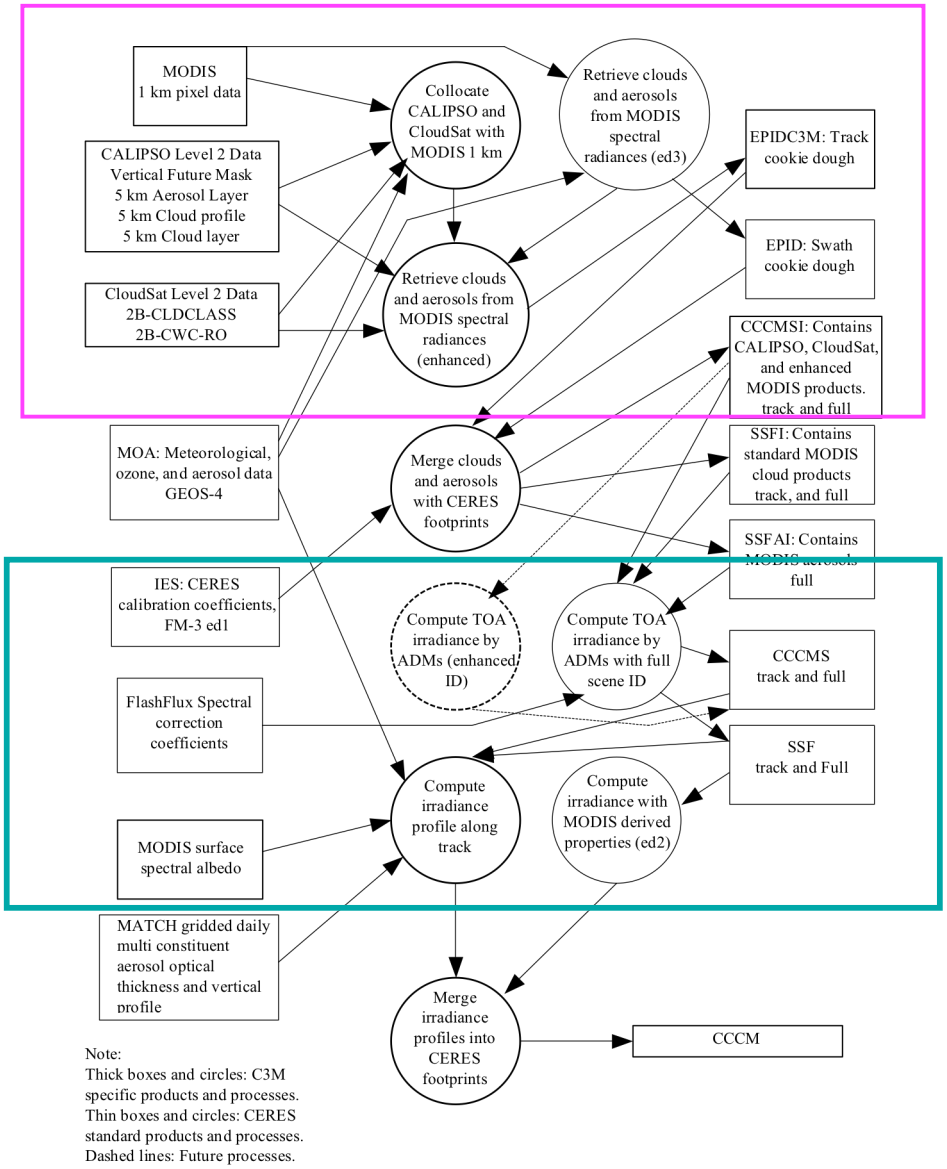
	SW Model - Obs. (RMS Diff.)	LW Model - Obs. (RMS Diff.)
CALIPSO+CloudSat + Ed3 clouds (W m^-2)	12.6 (50.0)	-1.3 (24.0)
CALIPSO+CloudSat+ Enhanced clouds (W m^-2)	8.8 (47.5)	1.0 (19.2)

Cloud vertical correlation length





Flow schematic of C3M processing



Schedule

- 2008: Validation of the product
- 2008: Comparison with CloudSat heating profiles
- Production: Spring 09, starting from July 2006.

Backups

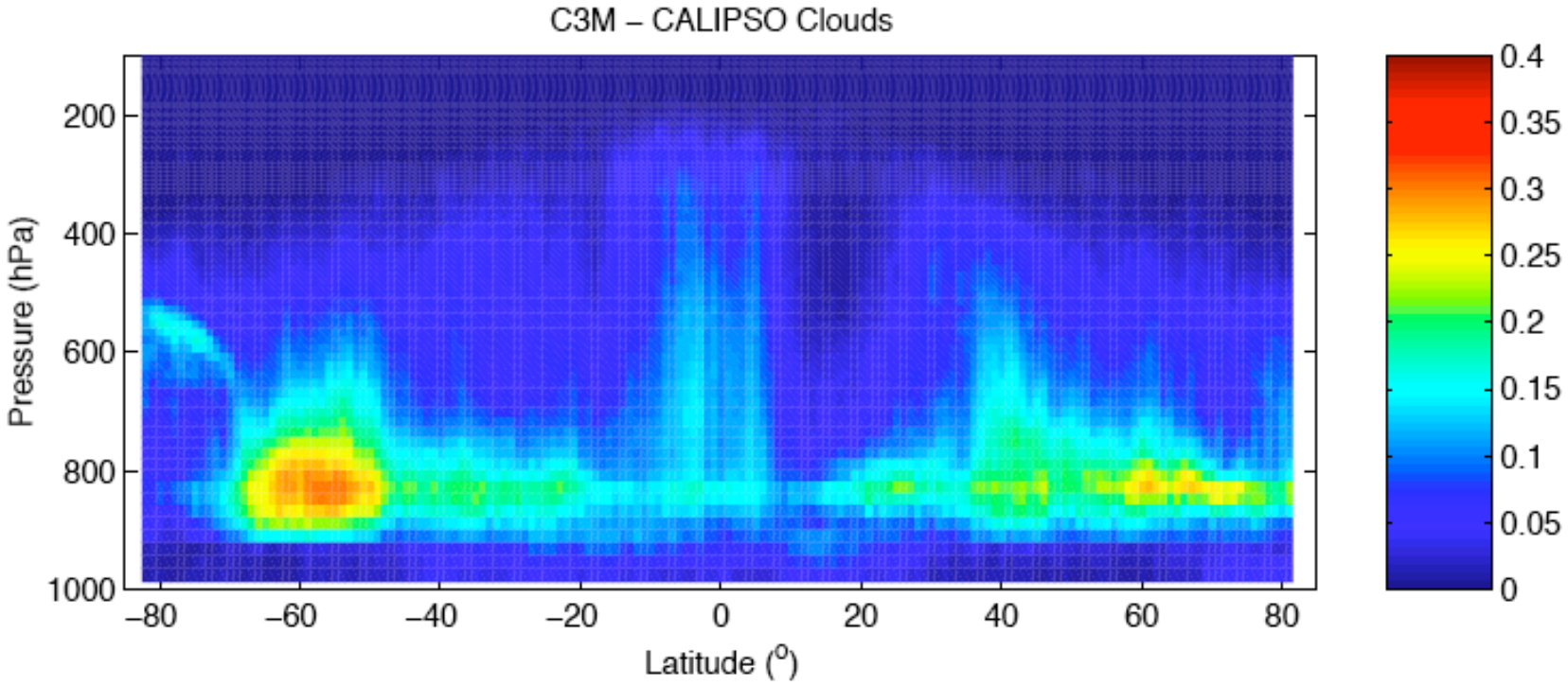
CALIPSO, CloudSat, CERES, and MODIS (C3M)

- Cloud and aerosol vertical profiles derived from CALIPSO and CloudSat are collocated
- CALIPSO and CloudSat cloud profiles are grouped and saved up to 16 different profiles.
- All MODIS-derived cloud and aerosol properties that are included in SSF over ground track of CALIPSO and CloudSat and the entire CERES footprint are included
- MODIS-derived spectral surface albedo
- Radiative flux profiles

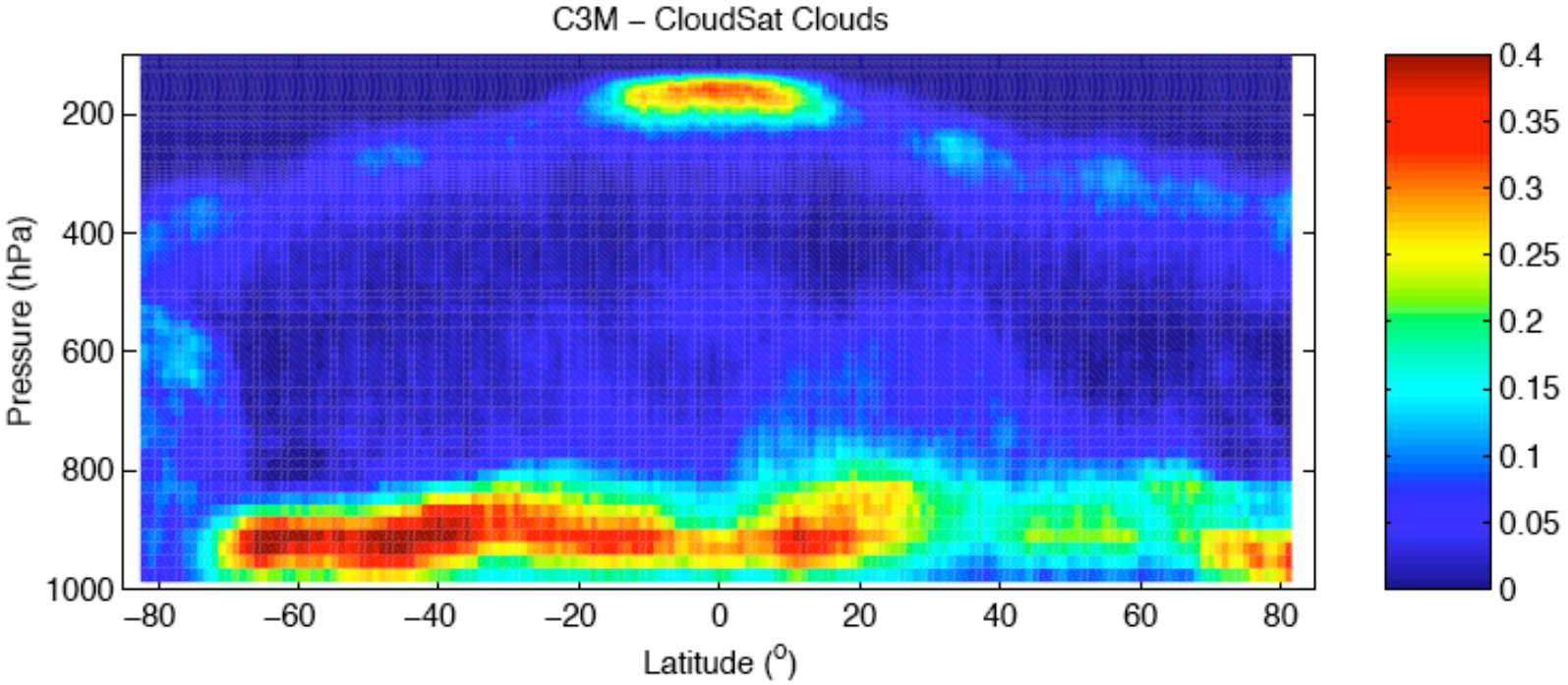
Work has been done so far

- Merged 1 month(April 2007) of CALIPSO (VFM), CloudSat (CLOUDCLAS), and MODIS.
- Developed best cloud mask strategy
- Developed surface albedo algorithm
- Made the draft of C3M data catalog

Missed by CALIPSO



Missed by CloudSat



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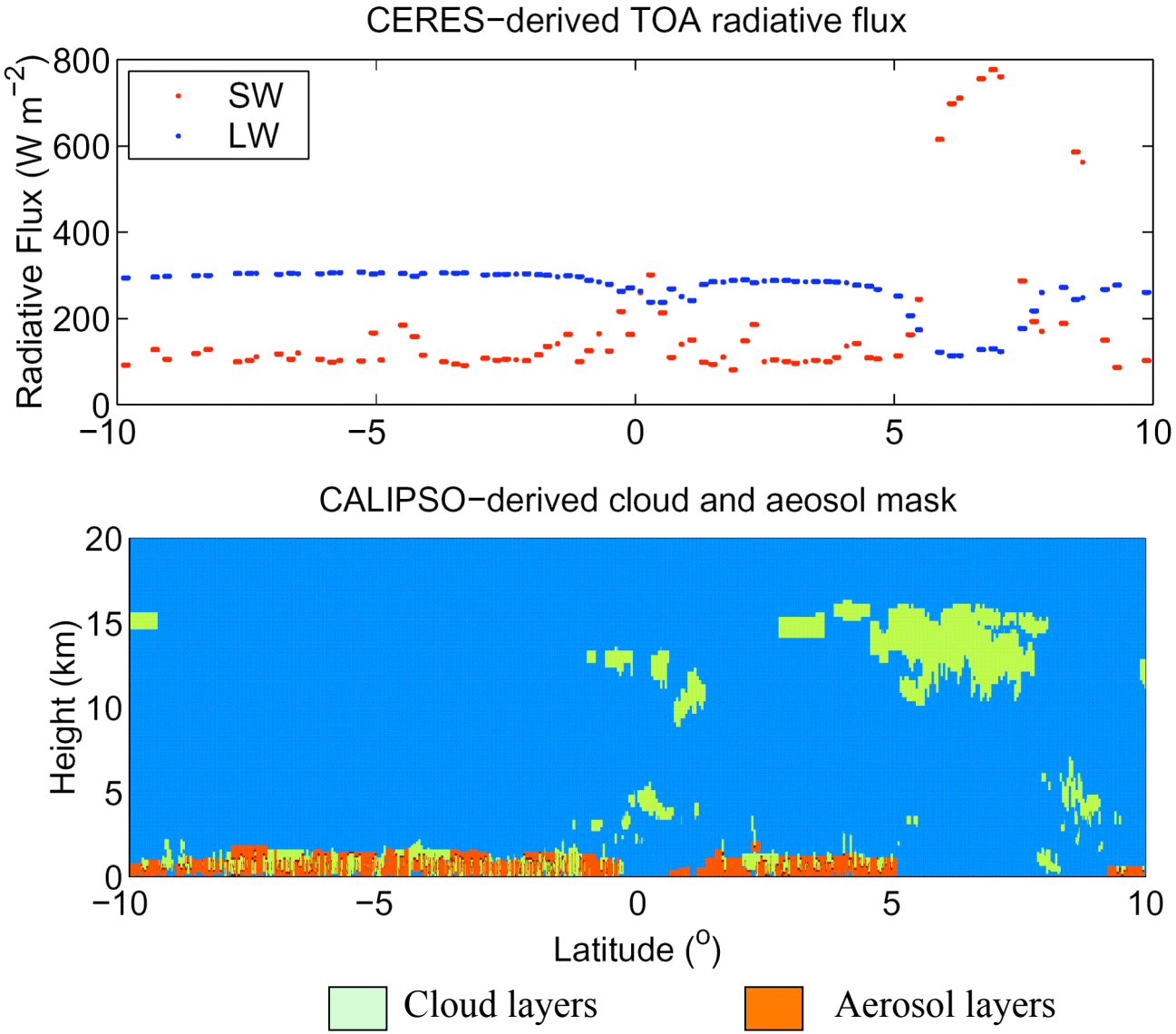

Cloud overlap profiles
CALIPSO and ClousSat

Cloud and aerosol properties
CALIPSO, CloudSat, and MODIS

TOA Irradiances
CERES

Irradiance profiles
Radiative transfer model